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Energy Union Factsheet Spain

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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE, THE COMMITTEE OF THE REGIONS AND THE EUROPEAN INVESTMENT BANK

Third Report on the State of the Energy Union

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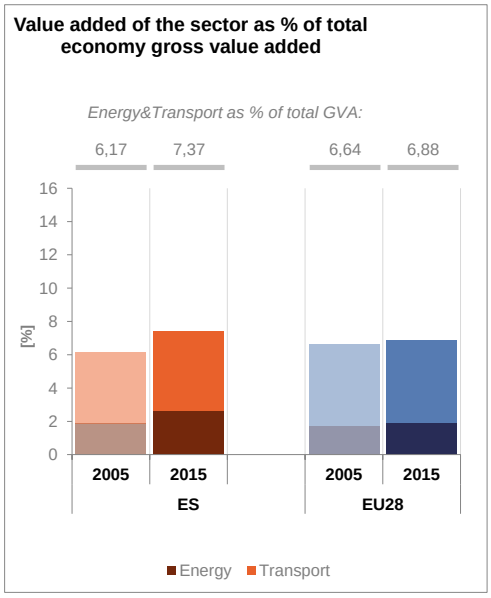
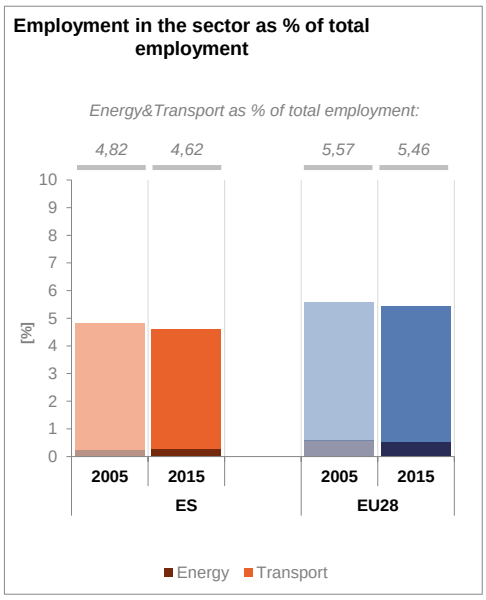
Spain

Energy Union factsheet[1]

1. Macro-economic implications of energy activities

Energy and transport are key sectors for the overall functioning of the economy as they provide an important input and service to the other sectors of the economy. Together, the activity in these two sectors[2] accounted for 7.4 % of the total gross value added of Spain in 2015. Similarly, their share in total employment[3] was 4.6% in 2015, of which 4.3 % in the transport sector and 0.3 % in the energy sector.





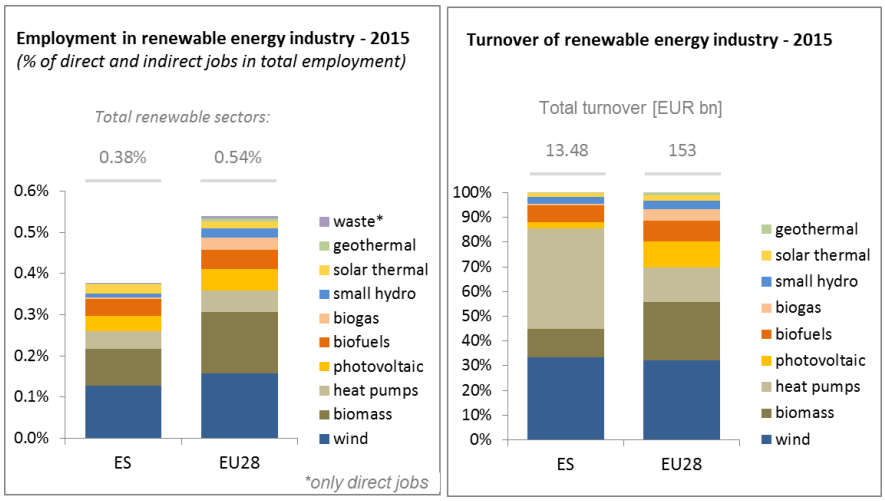
(source: Eurostat)

According to EurObserv'ER, in 2015, the share of direct and indirect renewable energy related employment in total employment of the economy in Spain was at about 0.38 %. The turnover of the renewable energy industry in the same year was estimated at around EUR 13.48 billion, the largest part being attributed to heat pumps (40.8 % of total renewable turnover), more than one third to wind (33.38 %), followed by biomass (11.35 %) and biofuels industries (6.88 %).

[1] The indicators used in this country factsheet largely build on indicators developed for the Commission Staff Working Document "Monitoring progress towards the Energy Union objectives – key indicators" (SWD(2017) 32 final) https://ec.europa.eu/commission/sites/beta-political/files/swd-energy-union-key-indicators_en.pdf

[2] Gross value added and employment in NACE sectors D-Electricity, gas, steam and air conditioning supply and H-Transportation and storage

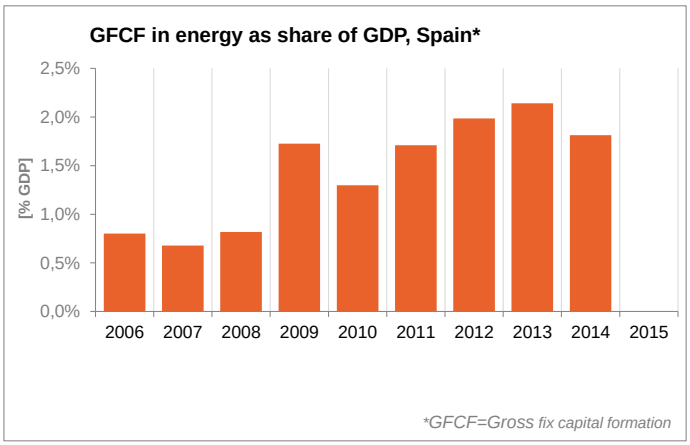
[3] National Accounts, Eurostat



(source: EC based on Eurobserv'Er and Eurostat)

The decarbonisation of the energy and transport sectors will require significant investments and economic activity beyond the remit of these sectors themselves. The energy transition implies a structural shift in economic activity. Energy-related investment and jobs will in part migrate from traditional fossil fuel based activities towards construction, equipment manufacturing and other services related to the deployment of low carbon and clean energy technologies. At the moment, the efforts related to the low-carbon and clean energy transition in sectors beyond energy can only be partially quantified and are therefore not included in this analysis.

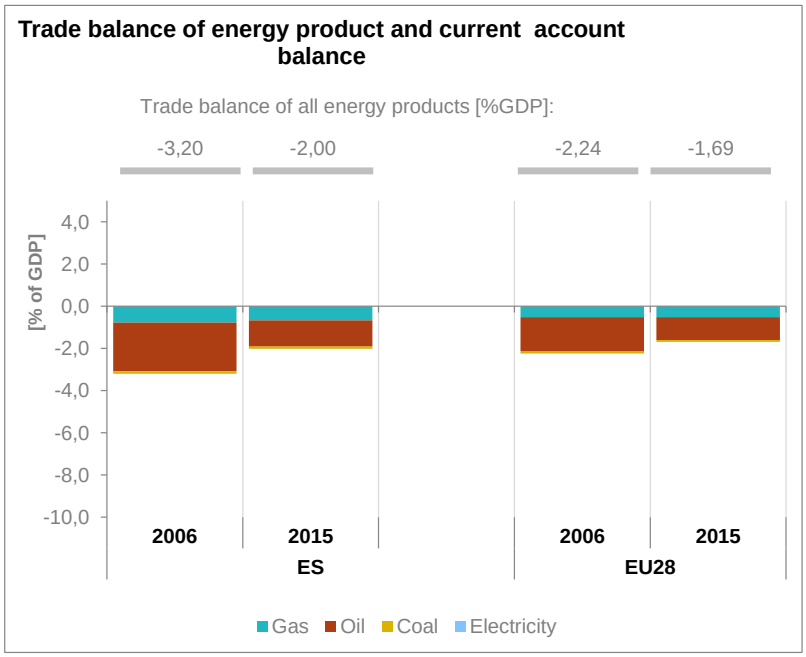
An indication of the level of efforts and challenges encountered by Spain in the energy sector is given by the Gross fixed capital formation (GFCF)[4]. Investments in the electricity and gas sectors, which are taken as reference sectors, have been on an increasing trend since 2010. They represented around 1.8 % of the country's GDP in 2014, higher than in the pre-crisis period and marginally lower than its peak in the previous year (2.1 %).



(source: Eurostat)

[4] Gross fixed capital formation consists of resident producers´ acquisitions, less disposals, of fixed tangible or intangible assets. This covers, in particular, machinery and equipment, vehicles, dwellings and other buildings. It also includes foreign direct investment (FDI). Steam and air conditioning supply are also included in the figures mentioned above as Eurostat reports electricity, gas, steam and air conditioning supply together.

In terms of trade, Spain is a net importer of fossil fuels, mainly of oil and gas. The trade deficit in energy products has fallen from about 3.2 % of GDP in 2006 to 2 % in 2015, influenced by improvements in energy efficiency and an increase of domestic renewable energy sources and by falling fossil fuel prices. The largest decrease as a percentage of GDP is accounted for by petroleum products, followed mainly by coal and gas.

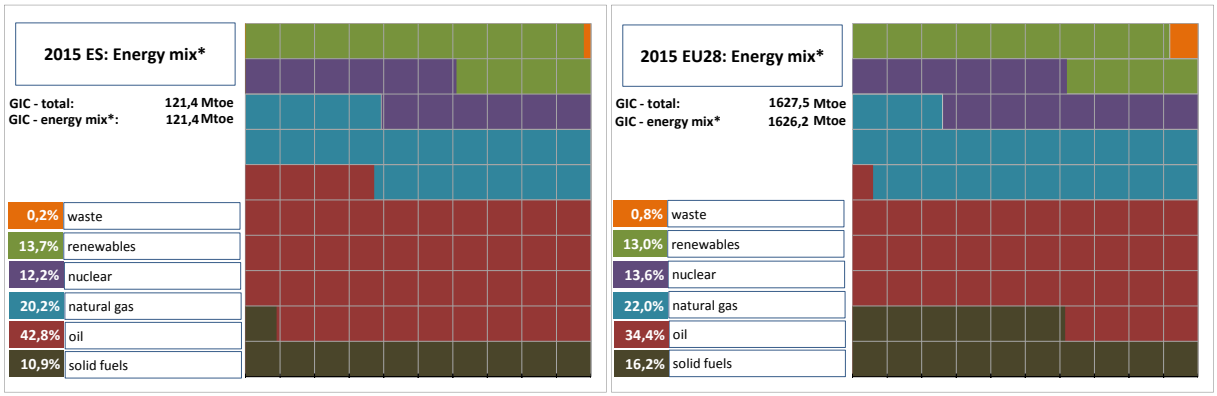


(source: Eurostat)

2. Energy security, solidarity and trust

2.1. Energy Mix

In comparison to the average primary energy mix in the EU, Spain's energy mix has a higher share of renewable energy (13.7 % vs 13 %) and a lower share of nuclear energy (12.2 % vs 13.6 %). Natural gas is close to EU average (20.2 % vs 22 %). Oil has a stronger presence (42.8 % vs 34.4 %) and solid fuels are below EU average (10.9 % vs 16.2 %).

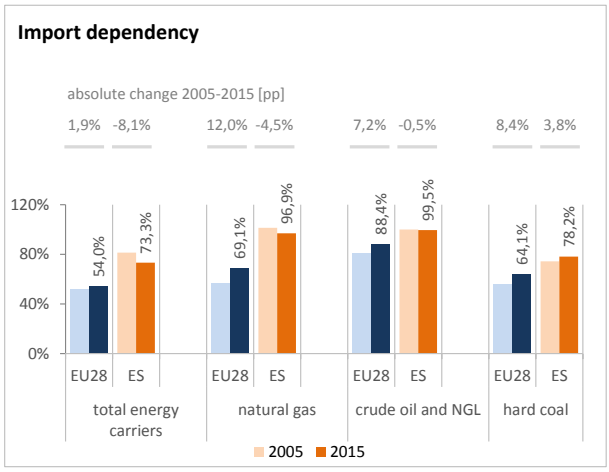


**energy mix as share share in GIC-excluding electricity and derived heat exchanges , GIC=gross inland consumption*

(source: Eurostat)

2.2. Import dependency and security of supply

Spain has an import dependency above the EU average for fossil fuels, as well as more specifically on gas and oil although it is a net exporter of refined products. 73.3 % of Spain's energy consumption comes from imports, quite above the EU average, mainly due to its reduced indigenous production of gas and oil. However, Spain has one of the highest levels of gas and oil supplier diversification in Europe.



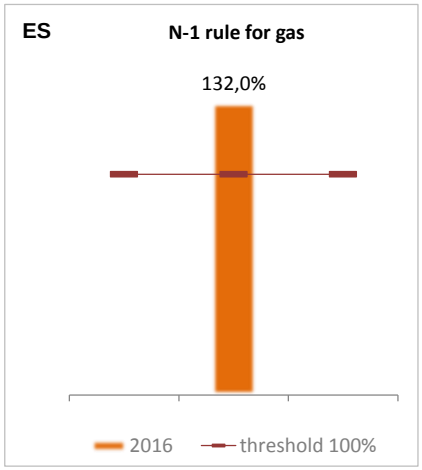
2015: Top non-EU suppliers for main energy carriers*

Natural gas		Crude oil and NGL		Hard coal	
ES	EU28	ES	EU28	ES	EU28
Algeria 59,7%	Russia 37,3%	Nigeria 16,7%	Russia 28,8%	Colombia 33,5%	Russia 29,1%
Nigeria 11,9%	Norway 32,8%	Mexico 13,7%	Norway 12,4%	Russia 21,5%	Colombia 24,3%
Qatar 9,3%	Algeria 10,7%	Saudi Arabia 10,5%	Nigeria 8,3%	Indonesia 20,6%	United States 16,0%

*share in total imports for the MS and in total non-EU imports for the EU28

(source: Eurostat)

The security of gas supply Regulation requires that, if the single largest gas infrastructure fails in one Member State, the capacity of the remaining infrastructure is able to satisfy total gas demand during a day of exceptionally high gas demand. Spain complies with the N-1 rule and benefits from a reliable and extensive internal infrastructure.

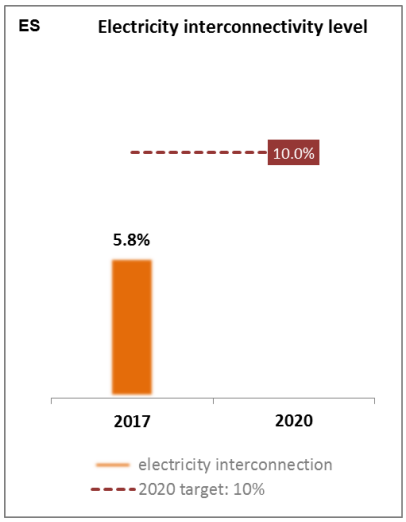


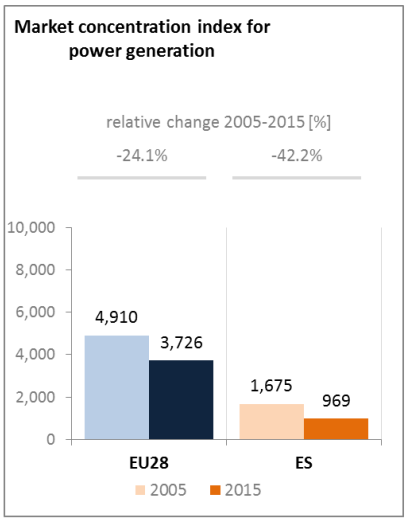
(source: gas coordination group)

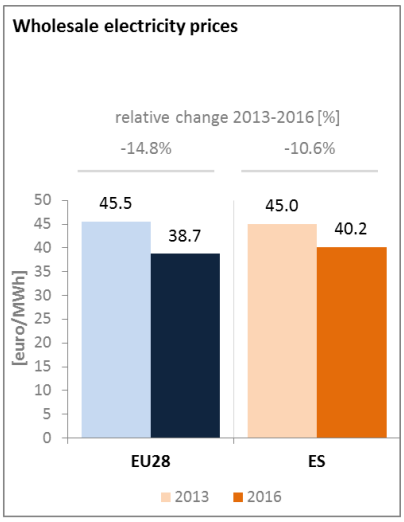
3. Internal market

3.1. Interconnections and wholesale market functioning

3.1.1. Electricity







(source: EC services based on ENTSOE and European power exchanges) *source: EC services based on Eurostat* *source: EC services based on Platts*

In 2017, the electricity interconnection level[5] of Spain was 5.8 %, calculated based on import capacity, well below the 2020 target of 10%. The electricity interconnection capacity with France is only 2.8 GW, despite the commissioning in 2015 of the EU co-financed Santa-Llogaia Baixas line. Regarding the connections with Portugal, the electricity interconnection which will increase the current interconnection capacity level to 3.2 GW, will be completed by 2018.

However, Spain remains insufficiently connected with the EU electricity market and cannot fully reap the benefits from a real and effective EU internal market. This has negative consequences for Portugal as well.

With respect to electricity, three projects of common interest- the Biscay Bay project and two other additional projects across the Pyrenees- have been given priority in the Madrid Declaration signed in 2015.

The Biscay Bay project, France — Spain interconnection between Nouvelle Aquitaine (FR) and the Basque country (ES) will bring the interconnection capacity between the two countries to 5000 MW by 2025 and Spain close to the 10% target.

The two planned projects for increasing the interconnection with France through the Pyrenees with estimated commissioning date on 2026, will increase the interconnection up to 8.000 MW.

[5] The interconnectivity level is calculated as a ratio between import interconnection and net generation capacities of the country (i.e. the 2017 value is the ratio between simultaneous import interconnection capacity [GW] and net generating capacity [GW] in the country at 11 January 2017, 19:00 pm as resulted from ENTSO-E Winter Outlook 2016/2017)

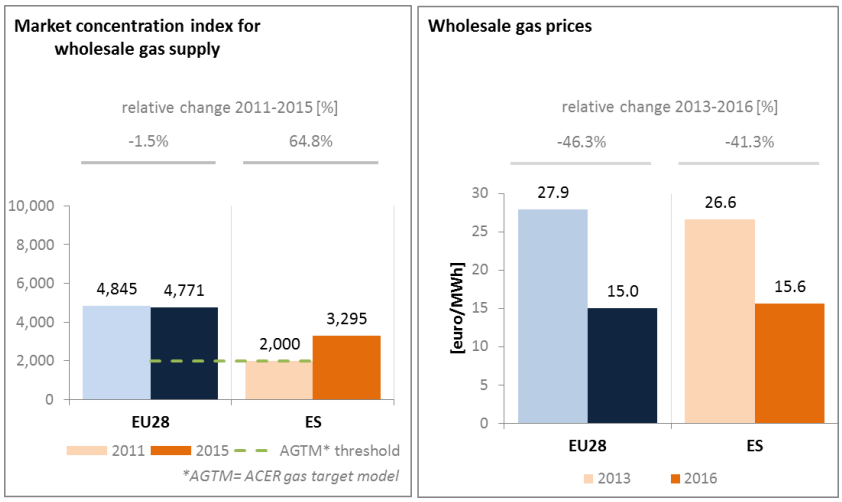
Concentration of the power generation market is below EU average (969 vs 3726). Wholesale electricity prices are slightly above the EU average. The electricity market could further converge and integrate with the wider European market, especially concerning intraday and balancing markets, once the adequate level of interconnections is in place.

Although Spain is integrated with the rest of Europe through the Price Coupling of Regions (PCR) project using the Euphemia (Market Coupling Algorithm), the Day-Ahead prices are quite above other EU countries. Therefore, advancing the integration of intraday or balance market will not bring benefits if they are not accompanied by an increase in the capacity of the interconnection with France.

Following the obtaining of 3.25 million euros of European co-financing within the framework of Connecting Europe Facility, RTE and REE defined the technical parameters of the project and jointly prepared the request for construction and environmental permits, in line with the requirements stated in the Annex VI.5 of the Regulation EU No 347/2013.

3.1.2. Gas

Concentration on gas supply markets continues to improve although with ratios lower than the EU average. If in 2015 the market concentration index for wholesale gas remained significantly lower than the EU average (3 295, as against 4 771), this level has increased since 2011 indicating a decrease in competition.



(source: ACER for the left graph and EC services based on on Platts, gas hubs, ESTAT for the right graph)

MIBGAS ("Mercado Ibérico del Gas" Iberian Gas Market) started its operations in December 2015, as the operator of Spain's organised gas market and with the aim of achieving in the future one single market with Portugal, similarly to the electricity sector (based on bilateral agreements between both Member States). During its first year of operation, progress has been made, but MIBGAS liquidity is still far below the liquidity levels of the main European gas hubs (only 2 % of the domestic demand was negotiated in MIBGAS in 2016). In this regard, several measures have been taken to increase market liquidity, including the appointment in January and June 2017 of a market creator (Gunvor International BV followed by AXPO IBERIA S.L.) As a result, liquidity has more than doubled in 2017, reaching 4.1% of national demand. Based on the future evolution of the market liquidity, the Hydrocarbons Law envisages the establishment of additional market creation obligations on dominant companies.

Projections based on the latest PCI list (2015) indicate that investments in energy infrastructure are expected to peak in 2019-20 and continue on a sustained level. In particular, new energy interconnections are foreseen, with 2 gas PCIs being commissioned post-2020 (Midcat and the 3rd interconnection between Spain and Portugal) and 4 new electricity interconnections, (electricity PCIs) by 2025: Biscay Gulf, two projects in the Pyrenees and a new interconnection between Spain and Portugal.

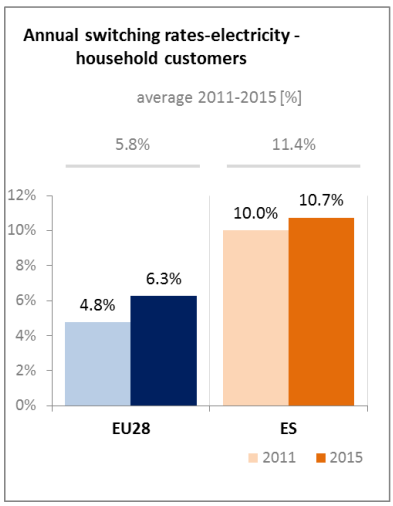
3.2. Retail electricity and gas markets

3.2.1. Electricity

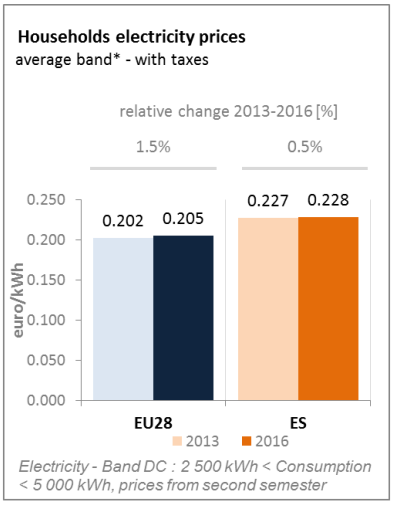
In 2015, households' electricity prices in Spain were above the EU average. Between 2013 and 2015, average band retail electricity prices for households remained stable.

Spain has a high annual switching rate by consumers from one electricity supplier to another, well above the EU average.

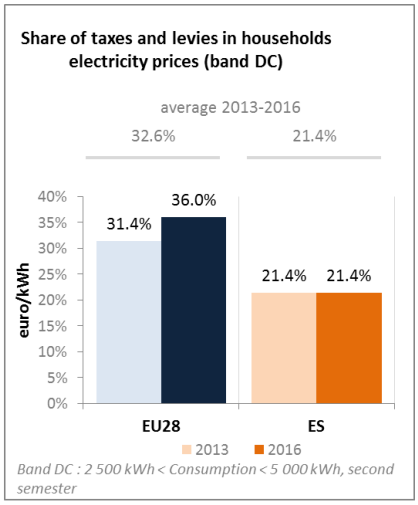
Spain is implementing a full roll-out of smart meters. In 2015, about 50 % of final customers had installed an electricity smart meter, and by the end of 2018 all household consumers will have a smart meter.



(source: ACER)



(source: Eurostat)



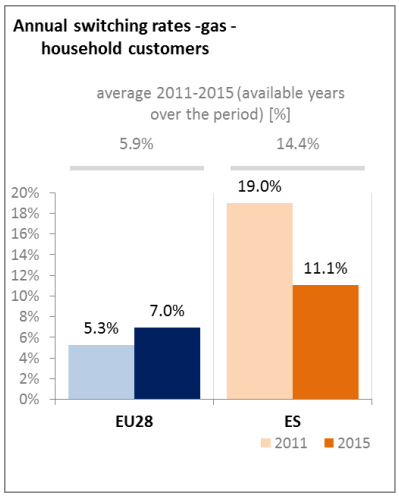
(source: Eurostat)

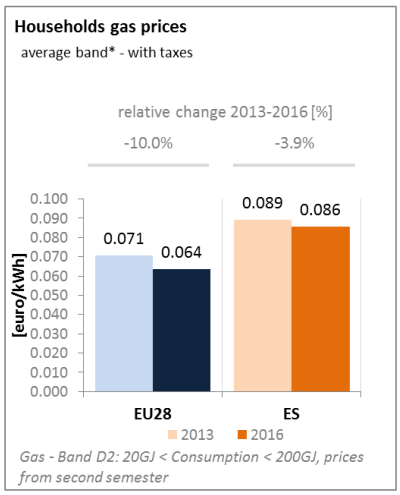
3.2.2. Gas

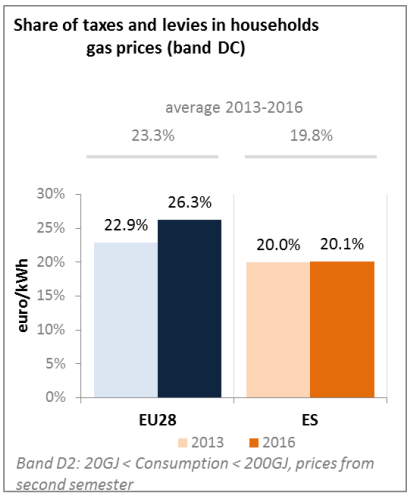
Gas represents an important share of households' energy consumption. Since the inauguration of the MIBGAS market in December 2015, a daily-based reference price is being published, although the low market liquidity needs to be further increased.

Domestic retail prices for gas are for all consumption bands amongst the highest in Europe. However, between 2013 and 2015, average band retail gas prices for households decreased (-4 %) more than the EU average. Since 2013, the level of taxes and levies in household gas prices has remained stable and slightly lower than the EU average.

Annual switching rates among household consumers have substantially decreased for gas (from 19 % in 2011 to 11.1 % in 2015), but remain well above EU average.



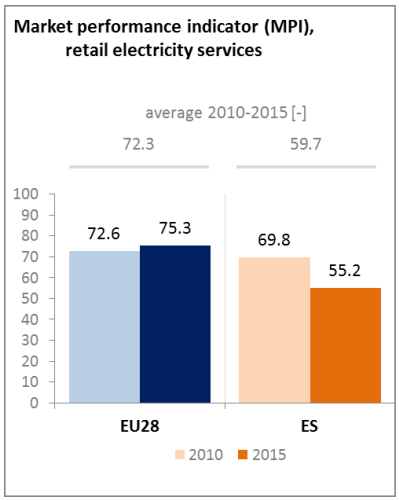


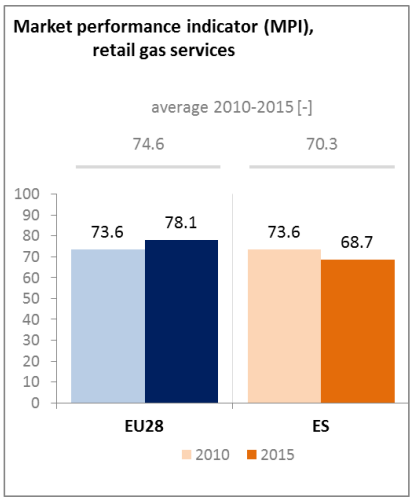


(source: ACER) (source: Eurostat) (source: Eurostat)

3.2.3. Market performance indicators

According to the periodical survey of DG JUST, the Spanish consumers are less satisfied than the EU average about the services received on energy retail markets.





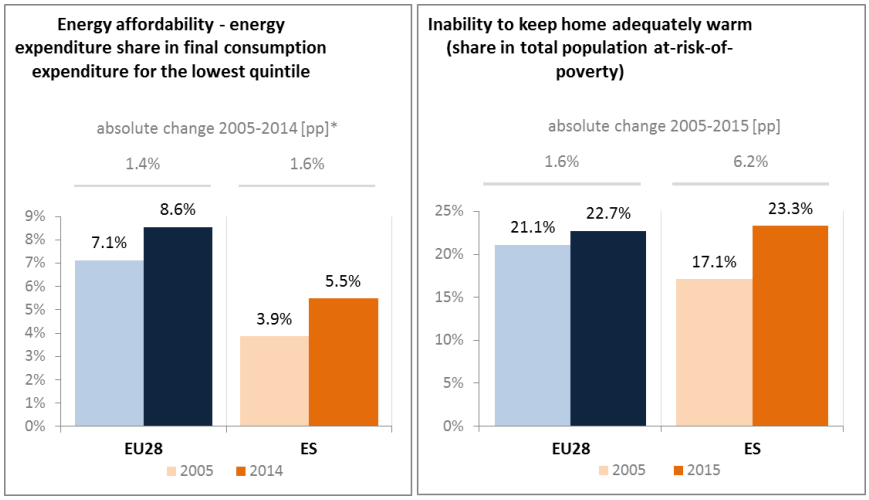
(source: DG JUST survey)

3.3. Energy affordability

In Spain, the share of energy in total household expenditure is below the EU average.

The cost of energy weighs on some categories of poor households. The percentage of population unable to keep their homes adequately warm (in the population at risk of poverty) increased between 2005 and 2015 (from 17.1 % to 23.3 %, above the EU28 average) due to the economic downturn.

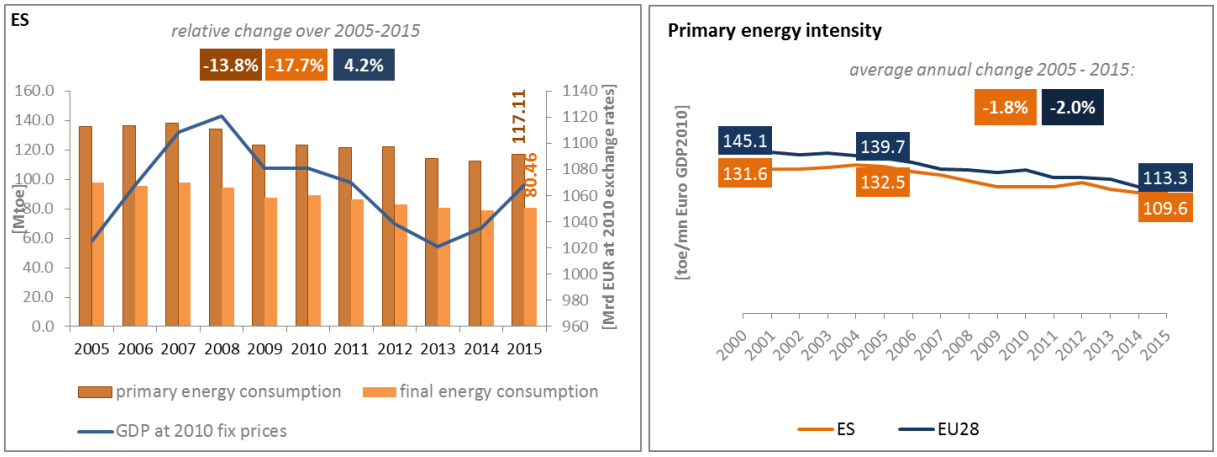
In 2015 with the upward economic cycle and the energy reform, the burden of energy costs for Spanish households started to decrease, after the increases recorded between 2008 and 2014. However, it continued to increase for low income households with children, as one in four still experienced difficulties in paying utility bills and keeping their home warm (EU-SILC 2015). Nevertheless, more than 2.4 million of households have been eligible in 2014 and 2015 for the electricity social tariff. In October 2017, the criteria of the social tariff were amended with a view to better targeting low income households and strengthening the protection of vulnerable consumers.



(source: ad-hoc data collection of DG ENER based on HBS with the support of Eurostat and national statistics)

4. Energy efficiency and moderation of demand

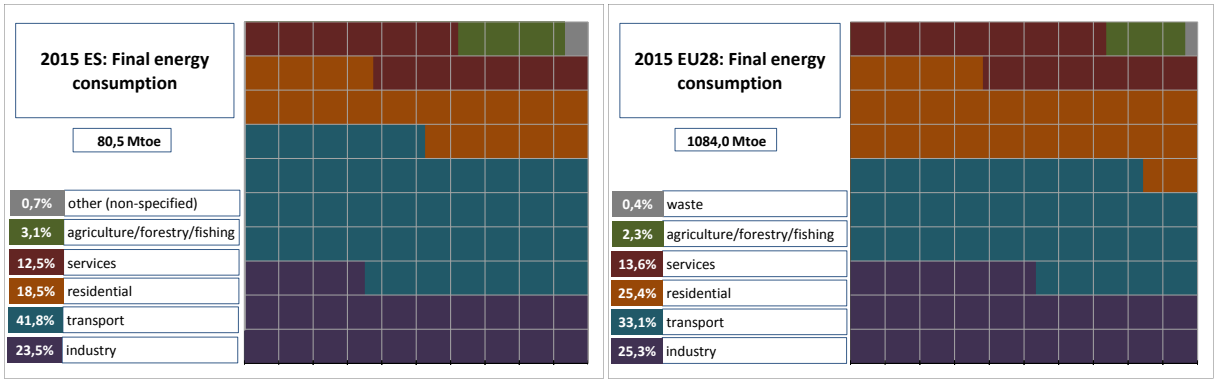
Since 2005, Spain decreased its primary energy consumption by 13.8 % to 117.11 Mtoe in 2015. Over the same period, final energy consumption also decreased by 17.7 % to 80.46 Mtoe in 2015. These levels are below the Spanish indicative energy efficiency 2020 targets of 122.6 Mtoe expressed in primary energy consumption and 87.23 Mtoe in final energy consumption (updated indicative targets communicated in the 2017 National Energy Efficiency Action Plan). However, the 2015 figures show an increase in both primary and final energy consumption as compared to 2014 levels. Spain should keep its commitment to the energy efficiency policies in order to make sure that demand remains below both targets during the next years, when a GDP growth rate is expected.



(source: Eurostat)

Primary energy intensity decreased over the period 2005-2015 and remained below the EU average.

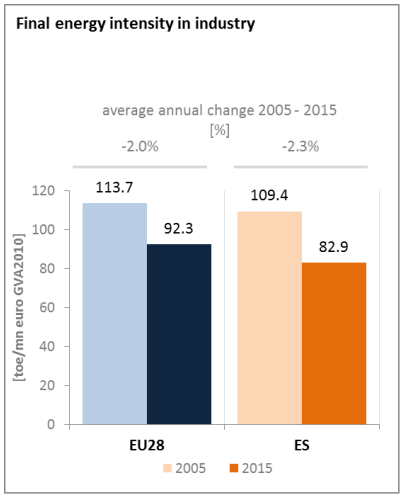
The energy consumption of Spain's transport sector was in 2015 at almost 42 % in total final energy consumption, well above the EU average of 33.1 %. Nevertheless, final energy consumption in Spain's transport fell by 20 % in Spain in 2014 compared to 2005 levels. The energy consumption of the residential sector is below the EU average, with a share in total final energy consumption of 18.5 %. On the contrary, the energy consumption of Spain's industrial sector was in 2015 at 23.5 % in total final energy consumption, below the EU average. As to the services sector, it is aligned with the EU average, with a share of 12.5 %.



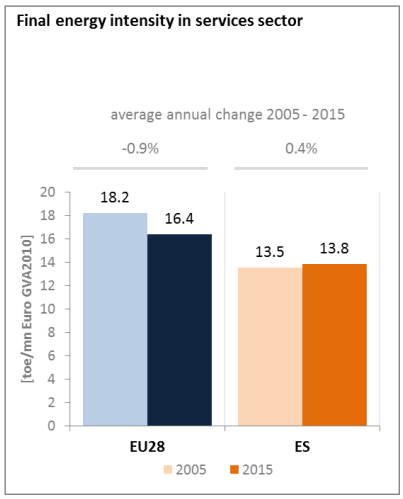
(source: Eurostat)

For the period 2014-2020, Spain allocated significant amounts of EU Cohesion policy funds for energy efficiency, in particular for the residential sector. This is expected to result in improved efficiency, therefore enabling many households to adequately warm their homes, reducing their risk of energy poverty. The energy efficient renovation of the building stock will also help Spain to fulfil its energy efficiency commitments for 2020.

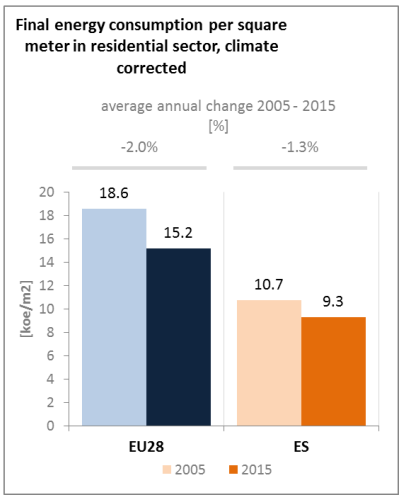
Spain has invested through the National Fund for Energy Efficiency more than 300 million euros since its establishment in 2014, and has recently approved a new framework of aids for projects in energy efficiency carried out by the local entities, partially financed by structural European funds and with a budget of 336 million euros in 2017. In addition, the Official Credit Institute (ICO) and the Institute for Diversification and Energy Saving (IDAE) will launch a new financing scheme with a total budget of 100 million euros.



(source: Eurostat)

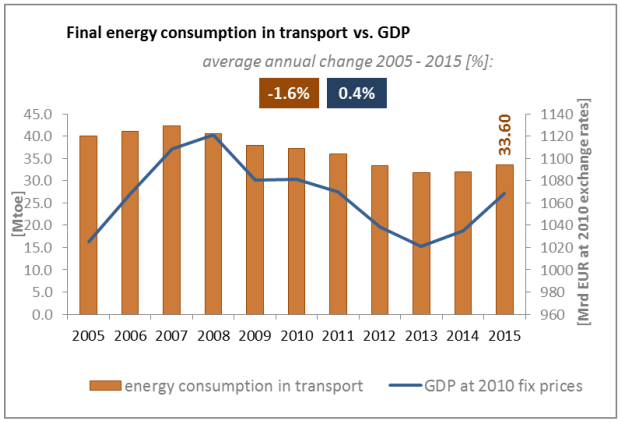


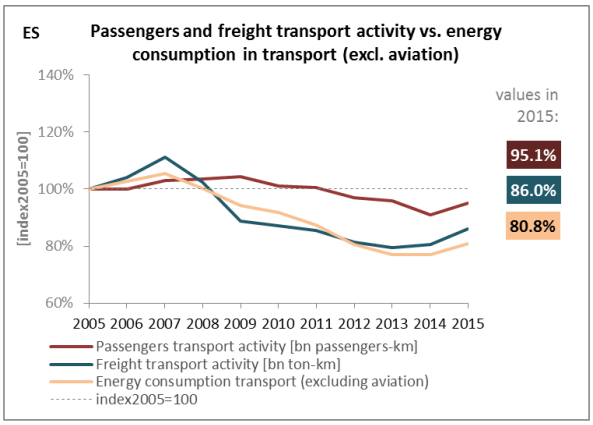
(source: Eurostat)



(source: Odyssee database)

Between 2005 and 2015 in Spain, the final energy consumption in transport recorded an average annual decrease of 1.6 %, well below the 0.4 % average annual increase of the GDP. The decrease of final energy consumption in transport was mainly driven by the decrease of freight transport activity affected by the economic context.

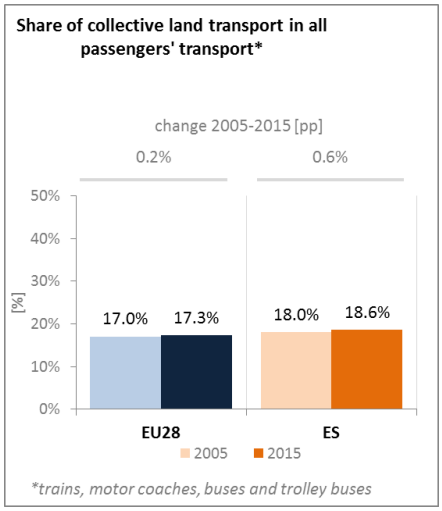




passengers transport activity=Private cars + bus + rail + tram & metro
freight transport activity=road+rail+inland waterways+pipeline

(source: Eurostat) *(source: Eurostat and DG MOVE pocketbook)*

The share of collective passengers land transport into total passengers' transport increased slightly between 2005 and 2015.



(source: Eurostat)

Spain has made significant efforts to improve the efficiency of the transport system, notably in the Spanish railway sector, where investments have been aimed at creating a high performance network interoperable with the rest of the European network (resulting in the improvement of travel times and an increase in the average speed of 30 % in the last decade). Between 2012 and 2016, incentives to the substitution of vehicles for more efficient ones have led to the substitution of 1,173,035 vehicles and to a total expense of EUR 1.115 billion. In this line, a program called PROMOVEA will be launched during 2017, aimed at promoting electric and alternative fuelled vehicles, and the deployment of electric charging points.

In terms of infrastructures and regulation, the 2017 Spanish National Plan of Reforms addresses various initiatives to improve the competitiveness of the Spanish Transport sector. The Plan

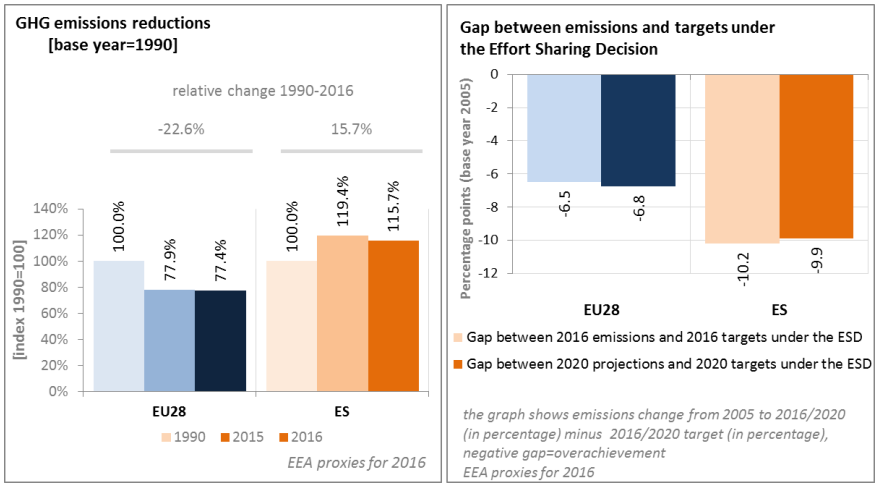
considers it essential to strengthen the Spanish logistics sector to boost the competitiveness of the Spanish economy. Some notable actions to be developed include encouraging the freight rail transport through the development of rail motorways between the main national and international logistics nodes and the promotion of the TEN-T Atlantic and Mediterranean corridors and the connection with the main Spanish ports. This will increase the competitiveness of the ports and reduce rates and fees in ports as well as airports and air traffic services developing the National Mobility Plan based on the principle of an integrated, citizen-oriented, sustainable and efficient transport system, and elaborating a Digital Agenda for Infrastructures.

5. Decarbonisation of the economy

5.1. GHG emissions

For the year 2020, Spain has a greenhouse gas emissions target of -10 % in the non-ETS sectors (compared with emissions in 2005). According to the latest national projections submitted to the European Commission in 2017 and taking into account existing measures, emissions are projected to decrease by 20 % by 2020 as compared with 2005. Therefore, Spain should reach its 2020 greenhouse gas emission reduction target with a 10 percentage points margin.

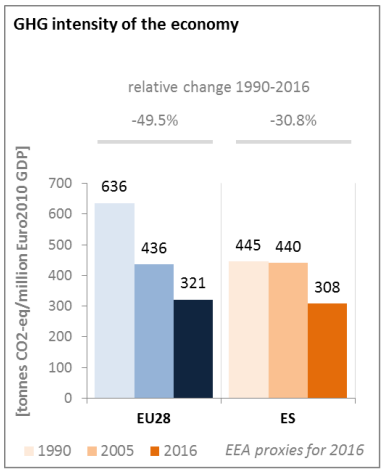
According to approximate data for 2016, emissions decreased by 16 % between 2005 and 2016 against an interim target of 6 %.

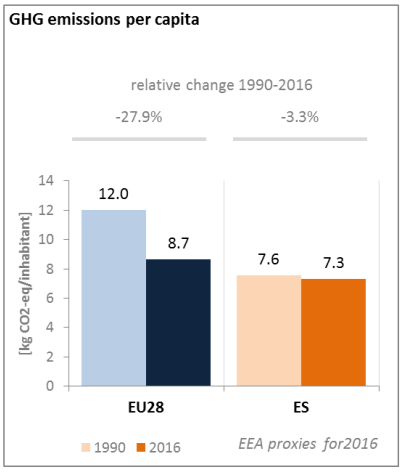


(source: EC and EEA)

According to 2016 EEA estimates, the GHG intensity of Spain's economy was below the EU average. In 2016, emissions per capita in Spain were also below the EU average.

In 2015 in Spain, the largest sectors in terms of emissions were the energy and transport sectors (1/4 of the total GHG emissions respectively) followed by industry (21 %), agriculture and fishery (12%) and residential and commercial sectors (8 %). In relative terms, the emissions from the transport, industry and agriculture sectors were above the EU average.



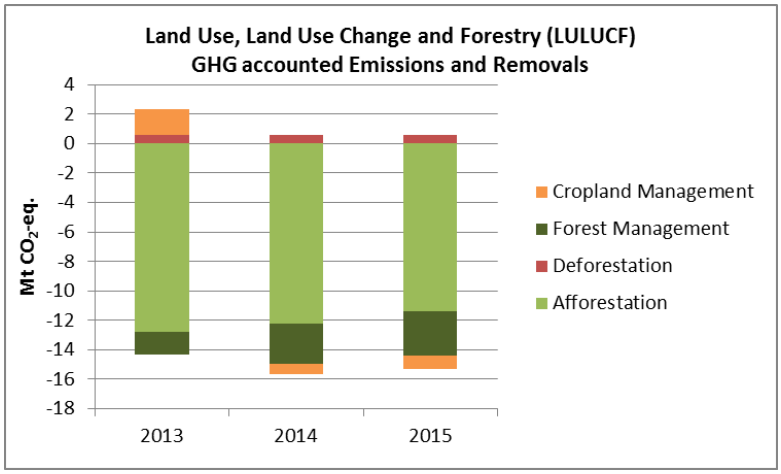


Largest Sectors of GHG Emissions in 2015	ES	EU28
Energy/power industry	27.0%	30.9%
Transport	24.8%	21.0%
Industry	21.4%	19.9%
Agriculture (incl. forestry & fishery)	14.1%	12.0%
Residential & Commercial	8.4%	12.8%
Waste	4.0%	3.2%
Other	0.1%	0.2%

(source: EC and EEA)

Preliminary accounts under the Kyoto Protocol for Spain show overall removals of -14.0 Mt CO_2-eq. as an annual average in the period 2013-2015. For comparison, the annual average of the EU-28 accounted for removals of -119.0 Mt CO_2-eq. It should be noted that in this preliminary simulated accounting exercise, removals from Forest Management did by far not exceed the accounting cap.

Removals by Afforestation are notably higher than emissions by Deforestation. Removals by Forest Management are a notable secondary contributor. Cropland Management changes from a relevant source to a minor sink. Overall, there is an increasing trend in removals mainly due to changes by Cropland Management and increasing removals by Forest Management. While removals by Afforestation declined they were counter-balanced by removals by Forest Management which nearly doubled over the course of the three-year period. Notable is also the shift of Cropland Management from a source to a sink, with emissions in 2013 and increasing removals in 2014 and 2015. Emissions by Deforestation remained constant.

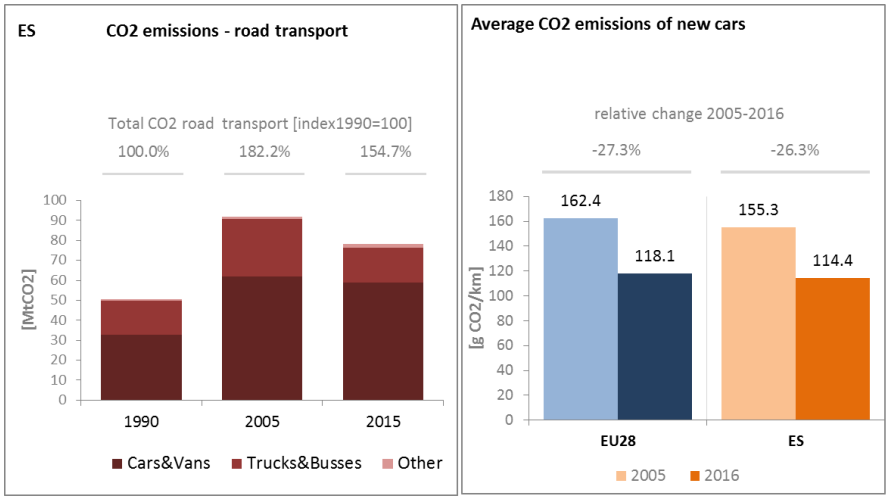


Note: Forest Management credits are capped and presented as yearly averages when the total Forest Management credits of the considered period exceed the simulated cap over the same period.

(source: EC and EEA)

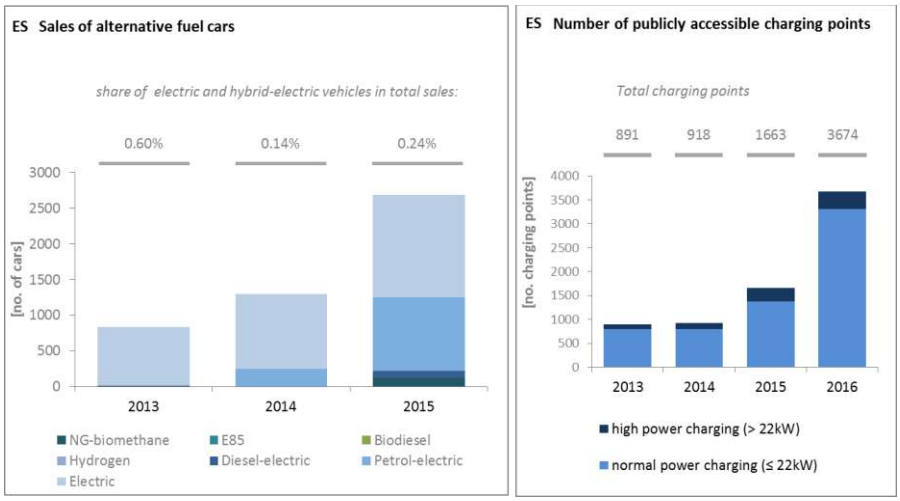
CO_2 emissions in transport and alternative fuelled vehicles

The average CO_2 emissions of new cars in Spain were in 2016 below the EU average and substantially decreased since 2005.



(source: European Environment Agency)

Over the last four years, the number of electric charging points in Spain has increased substantially, from 891 units in 2013 to 3674 units in 2016.



(European Environment Agency) *(European Alternative Fuels Observatory)*

National Policy Frameworks under Directive 2014/94/EU on alternative fuels infrastructure have to establish targets, objectives and measures for the development of the market of alternative fuels in the transport sector and the deployment of the relevant infrastructure. Spain has submitted its National Policy Framework as requested under article 3 of the Directive 2014/94/EU.

A detailed assessment of the Spanish National Policy Framework in terms of its compliance with the requirements of Directive 2014/94/EU on alternative fuels infrastructure, its contribution to achievement of long-term energy and climate objectives of the Union and coherence of its targets and objectives in terms of cross-border continuity has been published as part of the Communication

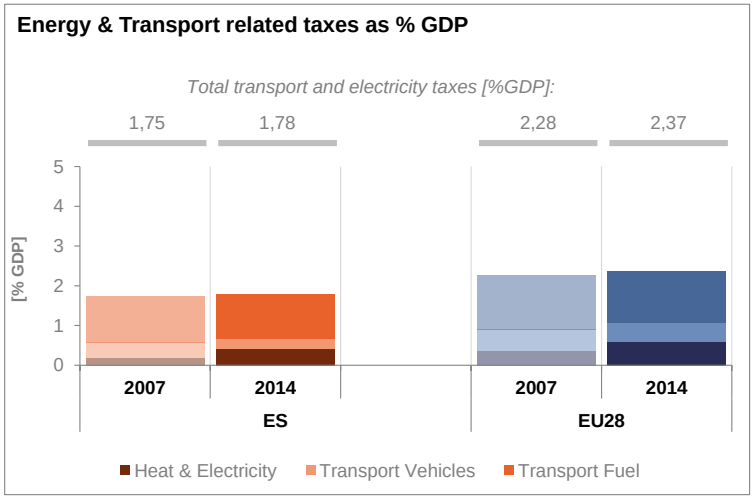
on Alternative Fuels Action Plans (COM(2017)652) and the related staff working document SWD(2017)365.

5.2. Adaptation to climate change

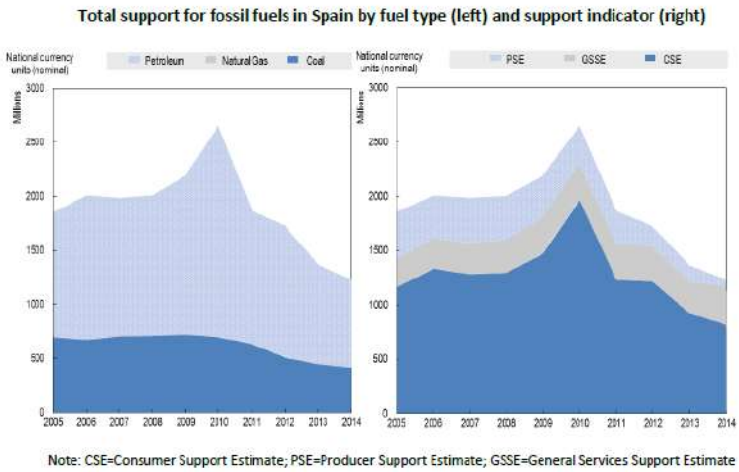
A National Adaptation Strategy, the PNACC, was adopted in 2006. Three working programmes have been adopted so far, in 2006 (WP1), 2009 (WP2) and 2013 (WP3). The following sectors were considered by the PNACC-WP3 to address adaptation actions during the period 2014-2020: biodiversity, forestry, water, soils, agriculture, fishing and aquaculture, tourism, health, finances/insurance, energy, industry, transport, urbanism and building, and finally hunting and inland fishing. A report on the assessment of the implementation of the PNACC is published every three years, the latest dating from 2014. Monitoring reports are structured according to the architecture of the PNACC and form the basis to follow up the progress in the implementation of the Strategy.

5.3. Taxes on energy and transport and fossil fuel subsidies

The overall tax burden on energy and transport in Spain amounts to 1.78% of GDP in 2014, which is among the lowest in the EU and 0.6 percentage points lower than the average. All three categories of taxation were lower than that of the EU average; this was in particular the case for the tax burden of the transport vehicles. With the exception of the taxes on electricity and heat, the other two categories presented a decrease between 2007 and 2014. In terms of CO2-related taxation, the car registration tax is based on CO2 emissions, while there is no direct CO2 component in the taxation of energy products.



(Source: Eurostat)



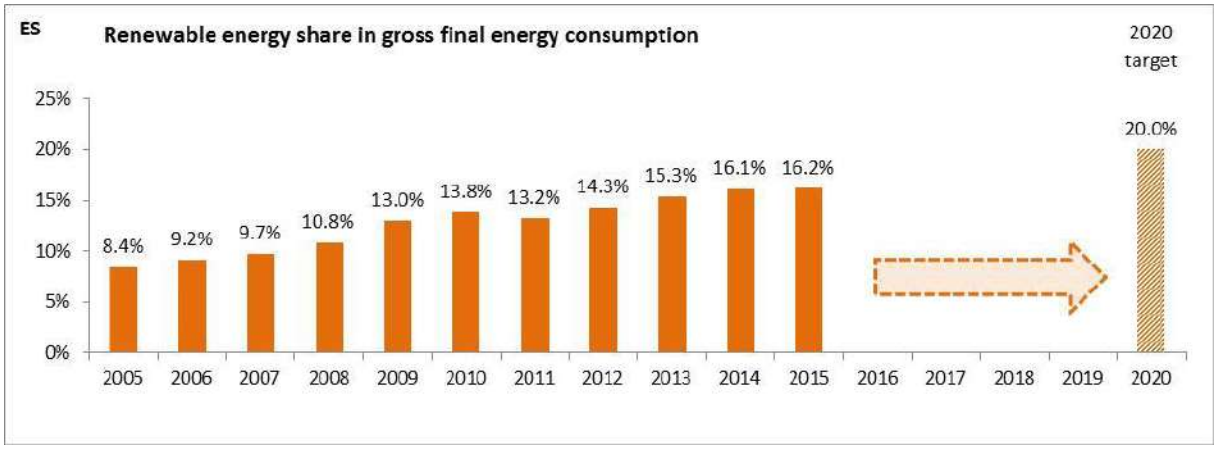
(source: OECD Inventory of Support Measures for Fossil Fuels 2015)

Spain mainly provides consumer support in the form of fuel-tax exemptions for specific users. The chief source of support to fossil-fuel production in Spain has been the financial assistance to the country's hard-coal mining industry according to the EU State Aid rules.

In May 2016 a €2.13 billion state aid scheme was approved aiming to alleviate the social and economic impact of closing 26 uncompetitive coal mines in Spain. The phasing out of any State Aid by 2018 is required by the relevant EU state aid rules and the Council Decision 2010/787/EU which requires that mines receiving such aid must be wound down by the end of 2018 at the latest[6].

5.4. Renewable energy

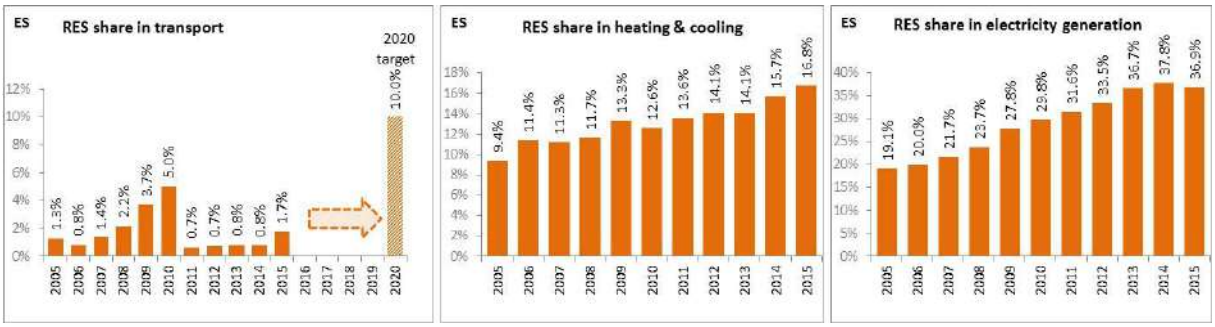
With a renewable energy share of 16.2 % in 2015, Spain is on track to reach its 2020 renewable energy target. However, there has been a visible slowdown in the increase of this share between 2014 and 2015 compared to the three precedent years and investments have slowed down due to regulatory changes.



(source: Eurostat-SHARES)

[6] http://ec.europa.eu/competition/state_aid/cases/244102/244102_1780173_276_2.pdf

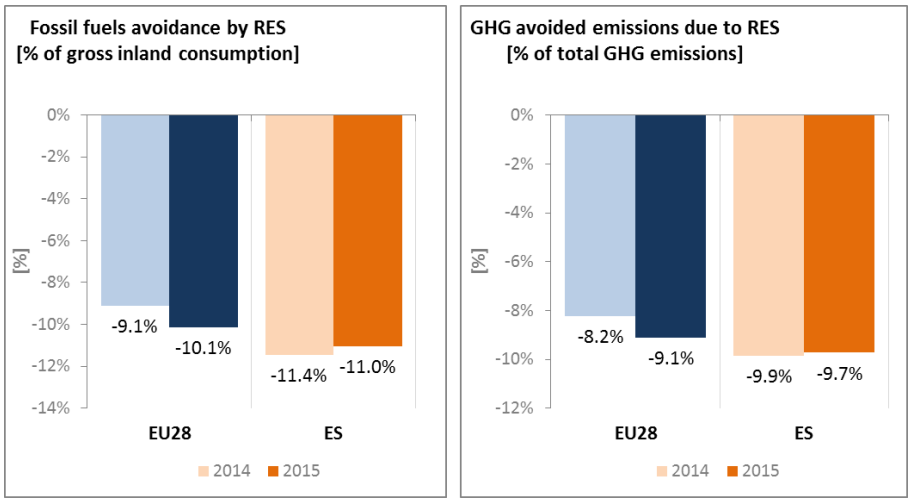
The share of renewable energy sources per sector in 2015 was the following: 36.9 % in electricity, 16.8% in heating and cooling, and 1.7% in transport. Spain is well below the 2020 target of 10 % of renewables in the transport sector. One of the reasons is that Spain only started to apply the sustainability criteria for biofuels in 2016.



(source: Eurostat-SHARES)

Some measures to further promote renewables should counteract the slowdown in the increase of the share of renewable energy. The tenders organised in 2016 and 2017 for allocating support to renewable electricity projects are seen as a step forward to fostering investment in renewables and meeting the 2020 target. The government has also started to apply biofuels sustainability criteria in 2016, which will make it possible to count biofuels towards the renewable energy targets.

Without the deployment of renewables since 2005, it is estimated that Spain would have consumed in 2014 about 11.5% more fossil fuels (for their gross inland consumption) and that GHG emissions would have been 9.8% higher[7].



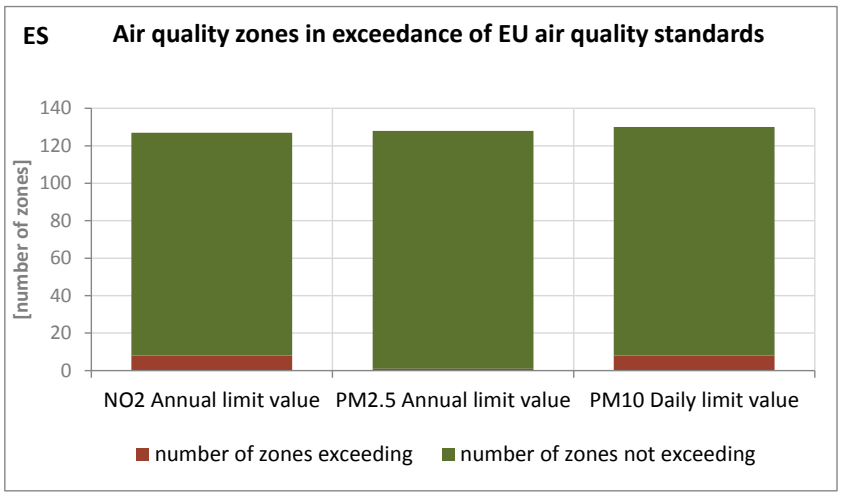
(source: EEA)

5.5. Contribution of the Energy Union to better air quality

[7] Avoided GHG emissions mentioned here have a theoretical character as these contributions do not necessarily represent 'net GHG savings per se' nor are they based on life-cycle assessment or full carbon accounting.

Air quality in Spain continues to give cause for concern. For the year 2013, the European Environment Agency estimated that about 23,940 premature deaths were attributable to fine particulate matter ($PM_{2,5}$) concentrations and over 4,280 to nitrogen dioxide (NO_2) concentrations[8].

For both pollutants Spain reported exceedances of the binding EU air quality standards[9] in a number of air quality zones. For the year 2015, Spain reported exceedances of the limit value for PM_{10} in 8 out of the 130 air quality zones in Spain, while exceedances of the limit value for $PM_{2.5}$ were reported in 1 zone and of the limit value for NO_2 in 8 out of 127 zones.



(source: EEA)

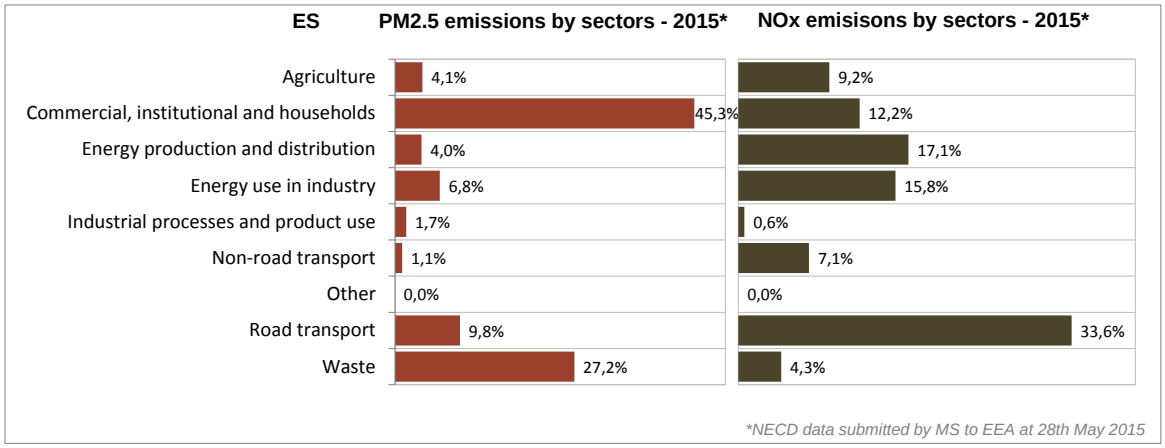
The health-related external costs from air pollution in Spain have been estimated to be more than EUR 22 billion/year (income adjusted, 2010), which includes the intrinsic value of living a healthy life without premature death as well as the direct costs to the economy such as healthcare costs and lost working days due to sickness caused by air pollution[10].

The Energy Union can substantially contribute to addressing these air quality problems through measures reducing emissions of both GHG and air pollutants such as PM and nitrogen oxides (NO_x) from major contributing sectors such as (road) transport, energy production, industry and residential heating (e.g. stoves and boilers).

[8] European Environment Agency, 2016, Air Quality in Europe – 2016 Report, table 10.2. The report also includes details as regards the underpinning methodology for calculating premature deaths.

[9] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, OJ L 152, 11.6.2008, p.1-44

[10] See also the EU Environmental Implementation Review Country Report for Spain, SWD(2017)42 final of 3.2.2017



(Source: EEA. This table reflects only sources of primary $PM_{2,5}$ emissions.)

6. Research, innovation and competitiveness

6.1. Research and innovation policy

Achieving a safe, clean and efficient energy system is identified amongst the priorities of Spanish research and innovation (R&I) strategy. The Spanish Strategy for Science and Technology and Innovation 2013-2020 and the State Plan of Scientific and Technical Research and Innovation implementing the Strategy are the main policy frameworks for energy-related research, development and demonstration (RD&D).

The Spanish energy R&I activities are shaped by four objectives: (a) Sustainability and reduction of greenhouse gas emissions to mitigate climate change; (b) Economic competitiveness to improve the efficiency of the Spanish and European grids through the development of the internal energy market; (c) Security of supply, in order to better coordinate national energy supply and demand in an international context; and (d) Social and technological changes fostering lower energy consumption patterns.

Spain is a very active contributor to the ongoing work of the Strategic Energy Technologies (SET) Plan. It participates in all the temporary working groups for the implementation of the integrated SET Plan except one, and leads the one dedicated to concentrated solar power. Spain has also made a point to link and coordinate the actions that derive from the State Plan for Scientific and Technical Research and Innovation 2013-2016 with European initiatives, and especially with the SET Plan.

Regarding the Horizon 2020 programme, Spain has received so far 12.6% of the EU contribution devoted to the 'secure, clean and efficient energy' part of the programme. As of September 2017, 554 participations from Spanish organisations have been awarded EUR 228 million in Horizon 2020 energy projects.

6.2. Investments and patents in the Energy Union R&I priorities

In 2015, public (national) investments in the Energy Union R&I priorities reached EUR 106 million, having increased by 10% compared to 2014. The largest share of investments (41%) was attracted by the Renewables priority of the Energy Union, followed by the Smart System priority (26%) and Sustainable Transport (15%). In the period 2007-2015, the maximum public investment was EUR 275

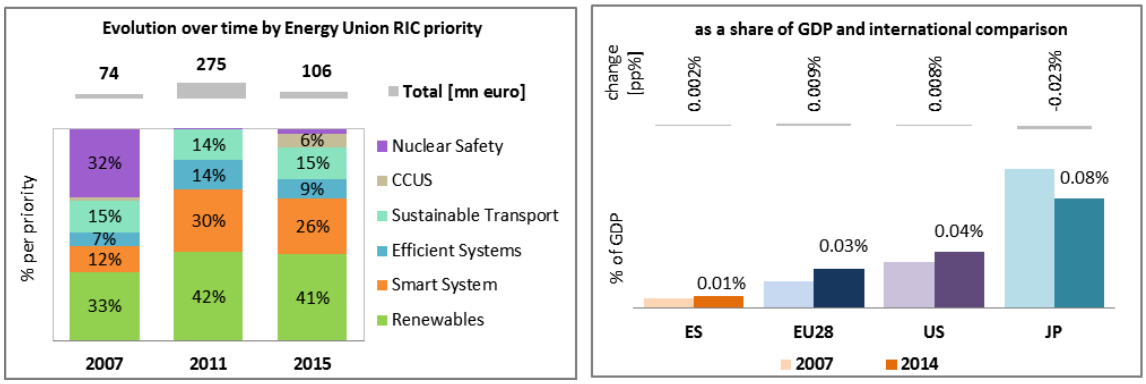
million, reported in 2011. In 2014, the most recent year for which data from most Member States are available, public investment per GDP in Spain was lower than the EU average[11].

Private investment in the Energy Union R&I priorities in 2013 was estimated at EUR 456 million (3% of the private R&I investment in Energy Union R&I priorities in the EU). The focus was on Renewables, which received 50% of these investments, followed by Efficient System with 20% and Sustainable Transport with 15%.

In 2013, the most recent year for which complete patent[12] statistics are available, 132 companies and research organisations based in Spain filed 216 patents in low-carbon energy technologies (3% of the EU total). The focus was on Renewables (52%), followed by Efficient Systems (19%) and Sustainable Transport (14%).

In 2013, private R&I investments and patents in Energy Union R&I priorities were lower than the EU average when normalised by GDP and by population respectively. In the period 2007-2013, both private R&I investments and the number of patents in Energy Union R&I priorities increased on average by 6% and 13% per year, which is comparable to the evolution of the same indicators at EU level (6% and 15% respectively).

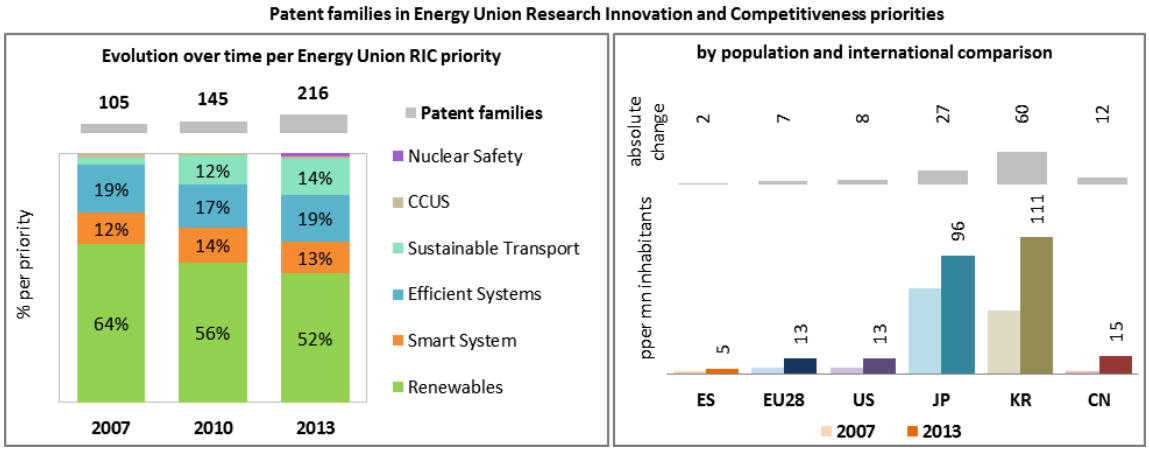
Public R&I investment in Energy Union Research Innovation and Competitiveness priorities



Note: The international comparison (right) is shown for 2014 (Spain had reported EUR 96 million). Reporting at EU level for 2015 is not as complete, and very few countries have reported for 2016.

[11] In previous years there had been a significant reduction in public R&I investment, as a result of budgetary restrictions in the context of the Excessive Deficit Procedure.

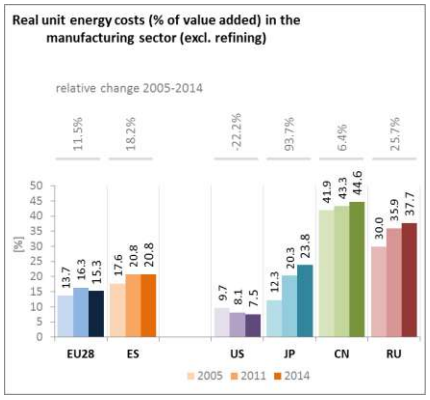
[12] In the context of this document, the term 'patent' refers to patent families, rather than applications, as a measure of innovative activity. Patent families include all documents relevant to a distinct invention (e.g. applications to multiple authorities), thus preventing multiple counting. A fraction of the family is allocated to each applicant and relevant technology.



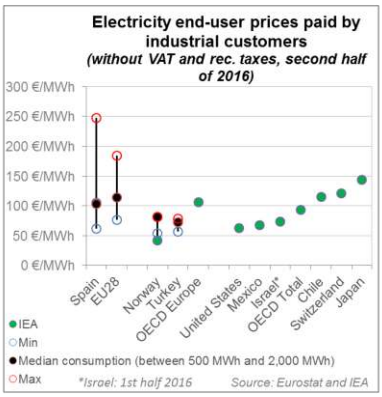
(Data sources: Public investment as available in the International Energy Agency RD&D Statistics database[13] for codes relevant to Energy Union RIC priorities. Patent data based on the European Patent Office PATSTAT database[14]. Private investment as estimated by JRC SETIS. Detailed methodology available from the JRC[15].)

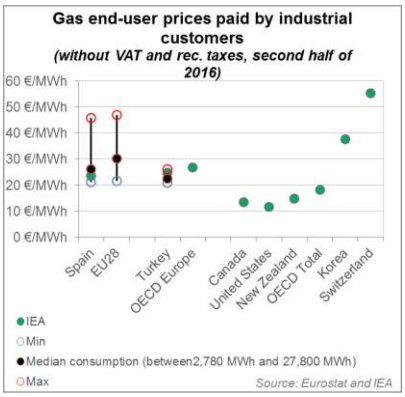
6.3. Competitiveness

In 2014, the real unit energy costs (RUEC)[16] in Spain (20.8) were above those at the EU average (15.3), almost three times more than those in the US but below those in Japan and China. Electricity prices paid by industrial customers are aligned with the EU average. Gas prices for industrial consumers are aligned with the EU and OECD averages.



(source: ECFIN)





(source: ESTAT and IEA)

Regarding the competitiveness in wind and solar energy, Spain is performing quite well in the wind sector due to a comparative advantage in key components of wind turbines such as blades, gearboxes and generators. As indicated by the revealed comparative advantage indicator[17] below,

[13] http://www.iea.org/statistics/RDDonlinedataservice/

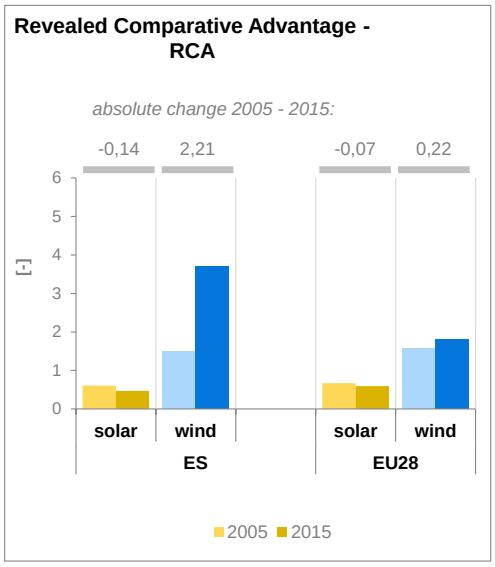
[14] https://www.epo.org/searching-for-patents/business/patstat.html#tab1

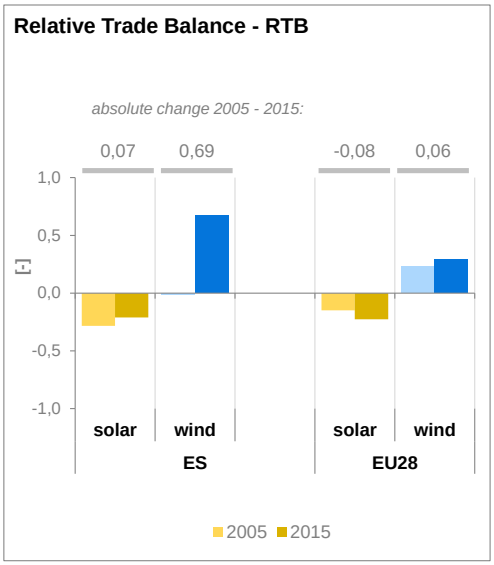
[15] https://setis.ec.europa.eu/related-jrc-activities/jrc-setis-reports/monitoring-ri-low-carbon-energy-technologies

[16] This indicator measures the amount of money spent on energy sources needed to obtain one unit of value added.

[17] The RCA index for product "i" is defined as follows: $\mathrm{RCA_i} = \frac{\frac{x_{j,i}}{\sum_i x_{j,i}}}{\frac{x_{w,i}}{\sum_i x_{w,i}}}$ where X is the value of exports, and j is the country and w is the reference group, the World economy. 2005 refers in the text to the indicator average over the 2000-2009 period, while 2015 represents the average over the 2010-2016 period. The same applies for the RTB indicator - see below.

the Spanish economy is not specialised in solar PV. The relative trade balance[18] confirms that Spain is a net exporter of wind components, well above the EU average in 2015. In particular, Spain recorded a significant increase in the relative trade balance of wind technology components between the period 2005 and 2015, by turning the relative marginal trade deficit into a trade surplus. Spain is a net importer of solar PV panels and components.





(source: UN comtrade)

7. Regional and local cooperation

Spain actively participates in various regional cooperation groups, with a key focus on increasing the interconnection with France for both electricity and gas:

- Regional High level Group South West, implementing the Madrid declaration, together with the European Commissioner in charge climate action and energy and the Ministers of France, and Portugal responsible for energy policy.
- TEN-E regional groups: North-South interconnection in Western Europe, both for gas and electricity.

Furthermore, Spain and Portugal are part of the electricity market coupling of regions since May 2014. This coupling now spans 19 countries, covering almost 85 % of European power consumption.

Lastly, Spain has shown interest to participate in the Clean Energy for EU islands initiative. The Commission announced the initiative on islands as part of the enabling actions of the Clean Energy Package. The initiative aims to accelerate the clean energy transition on islands to ensure islands provide secure and clean energy and energy related transport to their citizens and do so for affordable costs. In this respect, it is envisaged to bring forward an enabling framework which will facilitate deployment of investments on energy. A starting point is the signing of a political

[18] The RTB indicator for product "i" is defined as follows: $\mathrm{RTB_i} = \frac{\mathrm{X_i - M_i}}{\mathrm{X_i + M_i}}$ where $\mathrm{X_i}$ is the value of product's "i" exports and $\mathrm{M_i}$ imports.

declaration with interested Member States and the Commission in the margins of the Informal Energy Council scheduled for May 18 in Valetta (Malta).

European Territorial Cooperation – 'Interreg' – under EU cohesion policy also provides further opportunities for cross-border, transnational and interregional cooperation, including in the Energy Union areas.

Cities and urban areas have a key role in the energy and climate challenge. The Urban Agenda for the EU, established by the Pact of Amsterdam in May 2016, better involves cities in the design and implementation of policies, including those related to the Energy Union. It is implemented through partnerships, in which the Commission, Member States, cities and stakeholders work together on a number of important areas, including on Energy Transition, Urban Mobility, Air Quality, Climate Adaptation and Housing. Spain is participating in the partnerships on Energy Transition, with the city of Navarra regional housing agency Nasuvinsa as a member and on Climate Adaptation with the Province of Barcelona as a member.

By 2016, in the context of the Covenant of Mayors, the sustainable energy action plans delivered by 1376 Spanish municipalities had been assessed. Overall, these municipalities cover almost 25.5 million inhabitants. These municipalities committed to reducing GHG emissions by 22.7% by 2020 (as compared to 1990 baseline), a lower percentage reduction than at EU level, but leading to higher emissions per capita.

	No. of SEAPs submitted	Population covered by SEAPs [million]	Average GHG emissions [t CO2-eq/capita*year]			Relative GHG savings by 2020
			Baseline emissions		by 2020	
Spain	1376	25.54	4.70		3.64	-22.6%
European Union	5332	160.06	5.50		4.00	-27.2%

(source: JRC 2016. Notes: SEAP=sustainable energy action plan, GHG=greenhouse gas emissions)

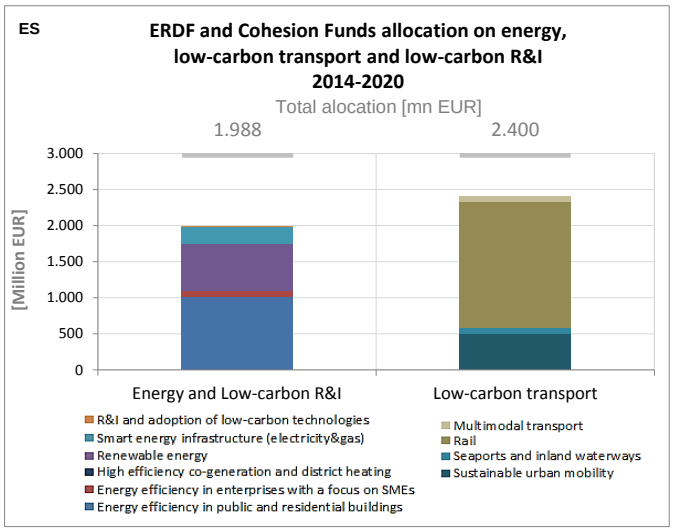
In Spain, by September 2016, 164 cities (covering 8.76 million inhabitants) have committed to conduct vulnerability and risk assessment and develop and implement adaptation plans in the framework of the Covenant of Mayors for Climate and Energy.

8. Cohesion policy and EU clean energy investments

EU cohesion policy makes a key contribution to delivering the Energy Union objectives on the ground, including important investment possibilities to implement energy policy objectives in Spain which are complemented by national public and private co-financing, aiming at optimal leverage. It also ensures integrated territorial solutions to energy and climate challenges, supports capacity building and provides technical assistance.

Over 2014-2020, cohesion policy is investing some EUR 1,981 million in energy efficiency improvements in public and residential buildings and in enterprises, as well as in renewable energy and smart energy infrastructure in Spain. Cohesion policy is also investing significantly in R&I and in SME competitiveness, based on the national and the regional strategies for smart specialisation. For Spain, the strategies (both the national and several regional ones) include a focus on safe, sustainable and clean energy and smart, integrated and sustainable transport, as well as actions

against climate change consequences and for resource efficiency. At this stage, at least EUR 8 million is foreseen for investments in R&I and adoption of low-carbon technologies in Spain, but this might increase further in line with the evolving content of the smart specialisation strategy. A further estimated EUR 2 400 million is invested in supporting the move towards an energy-efficient, decarbonised transport sector.



(source: DG REGIO)

These investments are expected to contribute to around 85,000 households with improved energy consumption classification, a decrease of around 1,629,176,000 kWh per year of primary energy consumption of public buildings, around 1,050 MW of additional capacity of renewable energy production and 621,000 additional users connected to smart grids, as well as to around 1,000 km of new railway lines, 2,360 km of reconstructed or upgraded railway lines and 15 km of new or improved tram and metro lines. Overall, the EU cohesion policy investments in Spain over 2014-2020 are expected to contribute to an estimated annual decrease of GHG emissions of around 6,580,000 tonnes of CO2eq.

For example, the Hospital de Sant Pau Art nouveau World Heritage Site in Barcelona has been sustainably restored into a cultural tourist attraction and Knowledge Centre. A strict adherence to sustainable building materials and techniques were applied to the restoration process. The project was able to attain a considerable amount of energy reduction and maximisation of water resources during the renovation. A geothermal system uses radiant floor heating, and sensors heat and cool the buildings based on demand. Three of the restored buildings achieved LEED silver certification (one of the most widely used green rating system). The total cost was EUR 78 million, of which the European Regional Development Fund (ERDF) contributed with EUR 22.5 million.

As another example, the National Renewable Energy Centre (CENER) is a technology centre, specialised in applied research and in the development and promotion of renewable energies. It has excellent qualifications and recognised national and international prestige. The CENER-CIEMAT Foundation started its activity in 2002 and its Board of Trustees is comprised of the Ministry of Economy, Industry and Competitiveness, CIEMAT (Research Centre for Energy, Environment and Technology), the Ministry of Energy Tourism and Digital Agenda, and the Government of Navarra. It currently provides services and performs research work in six areas: Wind, Solar Thermal and Solar Photovoltaic, Biomass, Energy in Buildings and Renewable Energy Grid Integration. CENER has cutting-edge technological infrastructures, with modern laboratories and facilities. The research and development of an offshore wind power generation system for deep water has been co-funded by the European Regional Development Fund (ERDF). The main objective is to generate knowledge and develop technology in order to extend and lead the construction of offshore wind farms in deep

water. The project has a budget of EUR 3,910,276 and was partially funded by the former Spanish Ministry of Science and Innovation and co-funded with ERDF funds within the INNPACTO 2010 program. CENER activities are focused on the experimental and numerical characterization of wind conditions for wind resource assessment and wind farm design. To this end, mesoscale meteorological and computational fluid dynamic (CFD) models will be validated in offshore conditions. Besides, a design tool will be developed for the optimization of the wind farm layout in deep water.

Through its support to sustainable transport systems, the Connecting Europe Facility (CEF) also contributes to the goals of the Energy Union. Following Spanish participation in the CEF – Transport 2014-2015 Calls, the Spanish action portfolio comprises 60 signed grant agreements, allocating EUR 900 million of actual CEF Transport Funding to Spanish beneficiaries (state-of-play February 2017)[19]. The transport mode which receives the highest share of funding is rail (78.5 % of actual funding). Some of the main rail actions under this portfolio aim at removing important bottlenecks and completing missing links along pre-identified sections of the Atlantic and Mediterranean corridors. Spain's main multimodal actions aim at improving rail to road connections in the Atlantic and Mediterranean corridors in order to improve the environmental performance of the network, in addition to removing bottlenecks. The multimodal portfolio also includes important innovation projects addressing the decarbonisation agenda, including actions promoting the use of LNG as fuel for medium to long haul road transport as well as in maritime transport.

Spain demonstrates a consistent involvement in maritime transportation projects. The country's efforts focus on improving the environmental performance of this mode of transport via expanding the use of alternative fuels. This is particularly noted under Innovation projects, where Spain continues its efforts for the introduction of LNG as marine fuel and the provision of shore side electricity in the ports of Canary Islands. Moreover there is noteworthy activity in upgrading the operational capacity of key Spanish ports, thereby contributing to the better integration of the maritime transport in the logistics chain.[20]

[19] Note that European Economic Interest Groups and International Organisations are excluded from the analysis.
[20] Source: INEA